BOX ARTICLE 1.1

Estimating Singapore's Value-Added in Gross Exports and Foreign Exports

INTRODUCTION

As a small open economy, Singapore is highly dependent on trade. There are two complementary ways to measure the importance of exports to the Singapore economy. The first is to measure the value-added (VA) generated from Singapore's gross exports of goods and services to other countries, where gross exports refer to the total exports to a country regardless of whether they are meant to meet final or intermediate demand.

The second is to measure Singapore's VA embodied in foreign exports.[1] Specifically, Singapore's VA would be embodied in foreign exports if Singapore was involved in the supply of intermediate goods or services further up the value chain in the production of these exports. For example, when Malaysia exports an electronics product to China, some of Singapore's VA would be embodied in Malaysia's exports because our sectors had provided intermediate goods and services to Malaysia's electronics sector which produced the exported product.

As a significant share of Singapore's goods and services exports are intermediates used by sectors overseas to produce the goods and services intended for export to another economy, it is pertinent to examine the second measure, alongside the first, to have a clearer understanding of how different export flows contribute to the Singapore economy.[2]

LITERATURE REVIEW

A number of previous studies had analysed the importance of exports to Singapore's Gross Domestic Product (GDP). For example, using the 2005 Singapore Input-Output (IO) tables published by the Department of Statistics, Jayaram and Neo (2011) found that the VA from Singapore's gross exports of goods and services accounted for 54 per cent of Singapore's GDP in 2005, with Singapore's exports to the G3 economies (the US, EU and Japan) collectively accounting for 20 per cent of Singapore's GDP. An update of the analysis by Chan et al. (2012) found that while the G3 economies still accounted for most of the VA from Singapore's gross exports in 2010, Singapore was deriving an increasing share of its VA from gross exports to China and other Asian economies.

METHODOLOGY AND DATA

Our study extends the previous studies in two ways. First, it updates the earlier estimates on the VA generated by Singapore's gross exports of goods and services using the OECD Inter-Country Input-Output (ICIO) tables. Using the OECD ICIO tables rather than Singapore's IO tables has the advantage of accounting for linkages between foreign economies outside of Singapore. Second, it explicitly examines the importance of foreign export flows (i.e., export flows between foreign countries) to the Singapore economy. Doing so enables us to quantify the relative importance of different foreign export flows to the Singapore economy arising from our role in global value chains.

1 *Foreign exports are defined as goods or services exported by an economy other than Singapore.*
2 *A related measure is the contribution of external sources of final demand to Singapore's GDP. Final demand refers to the consumption of final goods and services by consumers, the government and businesses in a particular country. Our current study focuses on Singapore's gross exports and foreign export flows as these better reflect global value chain linkages. However, there have been past studies that examined the contribution of external final demand to the Singapore economy. For instance, Lim and Zhou (2016) found that external final demand contributed to two-thirds of Singapore's GDP in 2015, with ASEAN-5, the US and China being the most important final demand markets. Similarly, a study by MAS (2018) found that final demand from Asia contributed to 21.9 per cent of Singapore's GDP in 2016, showing the importance of Asian final demand to Singapore's GDP.*

Our analysis uses the OECD Trade in Value-Added (TiVA) database which tracks the inter-country, inter-industry flows of goods and services trade and VA for 64 economies (viz. 63 economies, including Singapore, and the Rest of the World) across 34 industries. As the data in the OECD TiVA database is currently only up to 2011, we employ the RAS methodology to update the underlying ICIO tables to 2017 data.[3] We then use input-output methods to compute the contribution of our gross exports to Singapore's GDP, as well as Singapore's VA embodied in various foreign export flows. Refer to the Annex for more details of the methodology.

FINDINGS

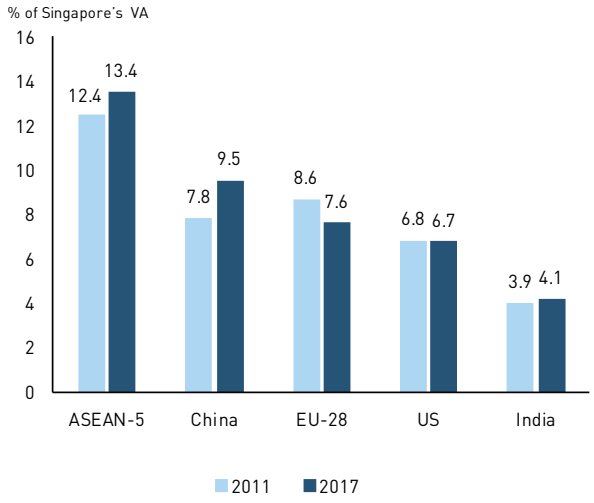
Trends in Singapore's VA Generated from Gross Exports

First, we estimate the VA generated by Singapore's gross exports of goods and services to various countries. We find that Singapore's exports to the ASEAN-5 economies (comprising Malaysia, Indonesia, Thailand, Philippines and Vietnam) and China contributed the most to Singapore's GDP in 2017, at 13.44 per cent and 9.47 per cent of GDP respectively (Exhibit 1). These were followed by Singapore's exports to EU-28 (7.55 per cent), the US (6.70 per cent) and India (4.13 per cent).

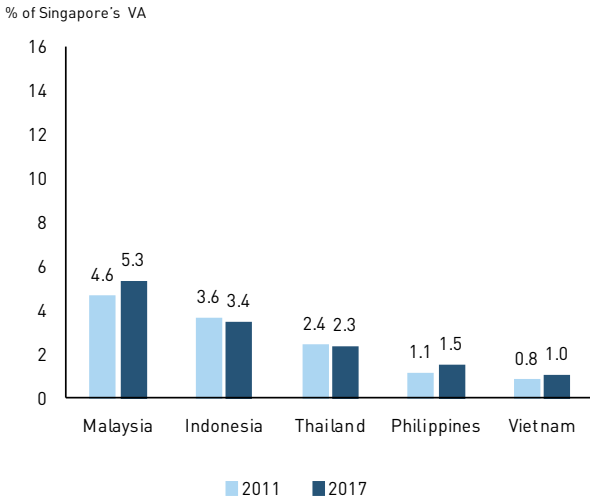
We also observe a shift in the drivers of Singapore's VA from gross exports towards the ASEAN-5 economies as a whole as well as China in recent years. Specifically, between 2011 and 2017, Singapore's VA from our gross exports to the ASEAN-5 economies rose from 12.45 per cent of GDP to 13.44 per cent of GDP, while the VA from our gross exports to China grew from 7.77 per cent of GDP to 9.47 per cent of GDP. Meanwhile, even though the share of Singapore's GDP arising from our gross exports to the EU-28 and US has fallen, they remain important contributors to Singapore's GDP at 7.55 per cent and 6.70 per cent respectively in 2017.

Exhibit 1: Singapore's VA Generated by Singapore's Gross Exports

Singapore's VA Generated by Singapore's Gross Exports



Singapore's VA Generated by Gross Exports to ASEAN-5 Countries



Source: OECD ICIO (2011), MTI-ECD estimates

3 *The RAS methodology is commonly used to update an input-output matrix to a more recent time period, when only partial information about its row and column sums is known for the more recent time period. For details on the RAS method, refer to Singapore Supply and Use, and Input Output Tables 2010, Department of Statistics (2014).*

Trends in Singapore's VA Embodied in Foreign Exports

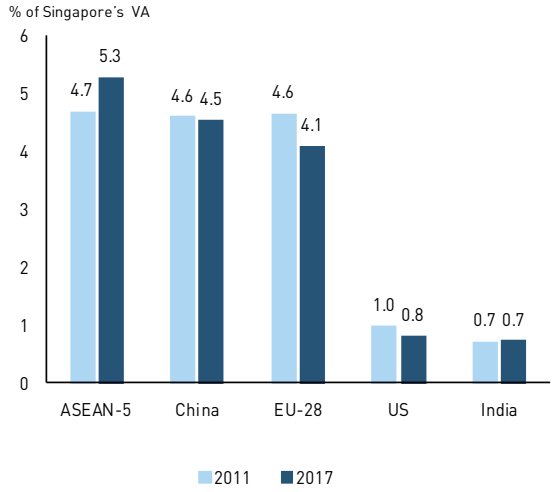
Next, we examine the trends in Singapore's VA embodied in foreign export flows. To recap, this measures Singapore's VA that is embodied within the exports of goods and services by a foreign country, because of our role in the supply of intermediate inputs used in the production of these goods and services.

Among all the foreign export flows, Singapore's VA embodied in the exports of the ASEAN-5 economies and China accounted for the largest shares of Singapore's GDP in 2017, at 5.25 per cent and 4.51 per cent respectively (Exhibit 2). These were followed by the exports of EU-28 (4.06 per cent), the US (0.79 per cent) and India (0.71 per cent).

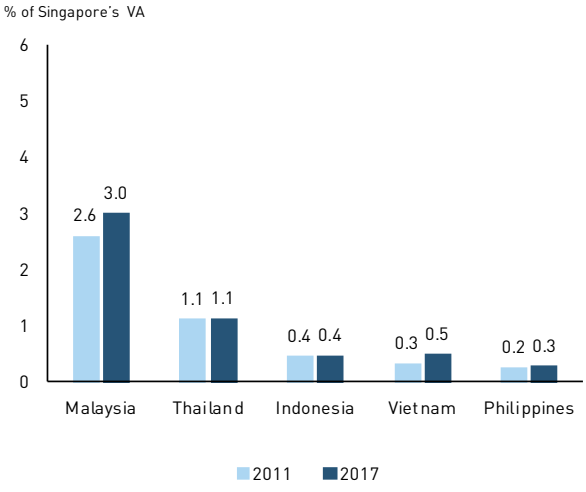
Over the period of 2011 to 2017, the share of Singapore's GDP embodied in ASEAN-5's exports increased from 4.66 per cent of GDP to 5.25 per cent of GDP. On the other hand, the share of Singapore's GDP embodied in the exports of China, EU-28 and the US declined slightly over the same period.

Exhibit 2: Singapore's VA Embodied in Foreign Gross Exports

Singapore's VA Embodied in Foreign Gross Exports



Singapore's VA Embodied in Gross Exports of ASEAN-5 Countries

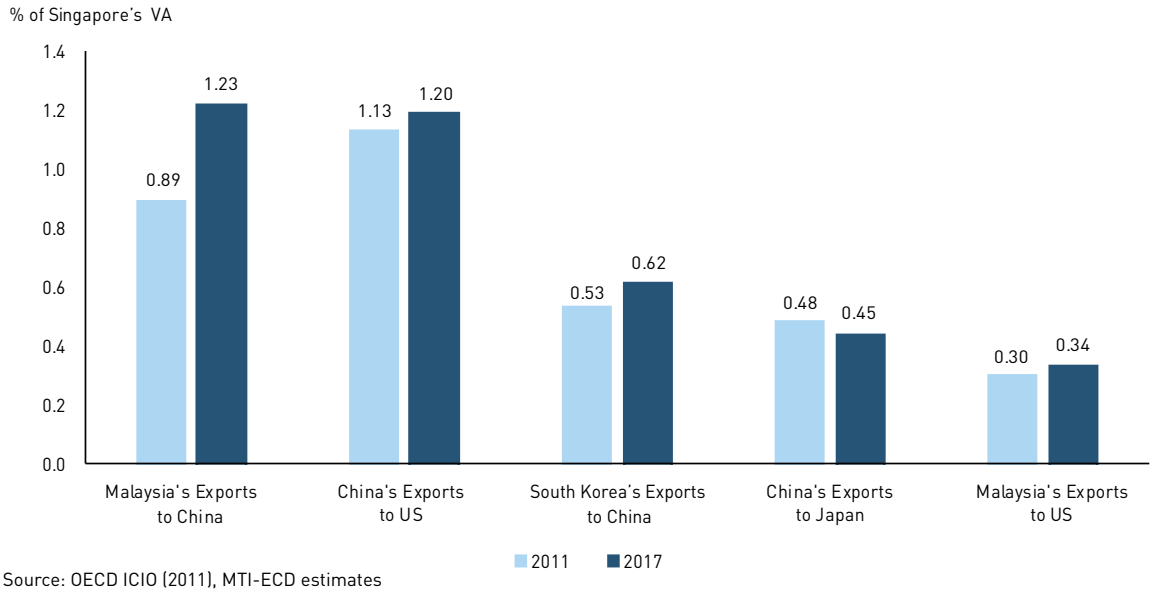


Source: OECD ICIO (2011), MTI-ECD estimates

Delving deeper into foreign export flows by country-pairs, we find that the bilateral flow that accounted for the largest share of Singapore's GDP was Malaysia's exports to China, at 1.23 per cent of Singapore's GDP in 2017 (Exhibit 3). This was followed by China's exports to the US, which accounted for 1.20 per cent of Singapore's GDP in 2017.

Over the period of 2011 to 2017, the share of Singapore's GDP embodied in Malaysia's exports to the US increased from 0.89 per cent of GDP to 1.23 per cent of GDP, leading it to overtake China's exports to the US as the bilateral foreign export flow that accounted for the highest share of Singapore's GDP. While the share of Singapore's GDP embodied in China's exports to the US has fallen, this trade flow remains important for Singapore's GDP, as do other bilateral foreign trade flows such as South Korea's exports to China, China's exports to Japan, and Malaysia's exports to the US.

Exhibit 3: Singapore's VA Embodied in Foreign Export Flows (Top 5 Flows)



Source: OECD ICIO (2011), MTI-ECD estimates

INSET 1: Singapore's VA Embodied in US-China's Bilateral Exports

In this inset, we examine in greater detail Singapore's VA that is embodied in export flows between the US and China. This is of interest given concerns about the potential impact of the on-going trade conflict between the US and China on the Singapore economy.[4]

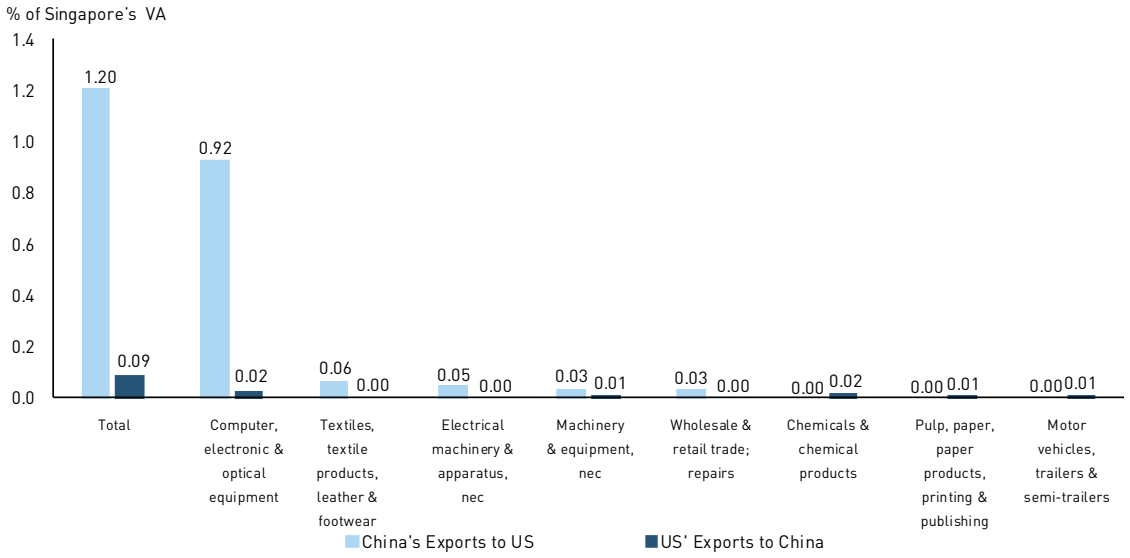
Our analysis shows that Singapore's VA embodied in China's exports of goods and services to the US accounted for 1.20 per cent of our GDP in 2017, while the VA embodied in the US' exports of goods and services to China accounted for a smaller 0.09 per cent of our GDP in 2017 (Exhibit 4). As such, in total, Singapore's VA embodied in the exports of goods and services between the US and China accounted for 1.29 per cent of our GDP in 2017, higher than the 1.2 per cent in 2011.[5] By products, about three-quarters of our VA embodied in China's exports to the US arose from China's exports of Computer, Electronic & Optical Equipment to the US.

While the estimate of 1.29 per cent of GDP represents Singapore's indirect exposure to US-China bilateral export flows, the actual impact of the on-going US-China trade conflict on the Singapore economy would likely be smaller for two reasons. First, only a portion of the bilateral goods exports between the US and China has been subjected to tariffs, whereas the estimate of 1.29 per cent of GDP represents Singapore's VA embodied in the bilateral exports of all goods and services between the US and China. Second, while the imposition of tariffs could lower the exports of the covered products between the US and China, it is not likely that the exports would fall to zero.[6]

A key caveat to the above analysis is that it does not take into account the adverse impact that could arise should there be an escalation of the US-China trade conflict that, in turn, triggers a sharp fall in global confidence or a tightening of global liquidity conditions. In such a scenario, global consumption and investment, and hence global growth, would decline, thereby causing a drop in the global demand for Singapore's exports. The negative impact on the Singapore economy would likely be larger in this case.

4 *Since July 2018, the US has imposed tariffs on around US$250 billion worth of imports from China, while China has imposed retaliatory tariffs on around US$110 billion worth of imports from the US.*
5 *Specifically, in 2011, China's exports to the US accounted for 1.1 per cent of Singapore's GDP, while US' exports to China accounted for 0.08 per cent of Singapore's GDP.*
6 *For example, if we assume unit elasticity, a 10 per cent tariff will only lead exports of the covered products to fall by 10 per cent.*

Exhibit 4: Singapore's VA Embodied in US-China Bilateral Export Flows



Source: OECD ICIO (2011), MTI-ECD estimates

CONCLUSION

In this article, we analyse Singapore's VA generated from our gross exports of goods and services, as well as Singapore's VA embodied in foreign export flows. Our key findings are as follows. First, over the period of 2011 to 2017, the share of Singapore's GDP generated from our gross exports of goods and services to the ASEAN-5 economies and China has increased, although our gross exports to other key trading partners such as EU-28, US and India remain important for the Singapore economy. Second, the share of Singapore's GDP embodied in the goods and services exports of the ASEAN-5 economies has similarly increased over the same period. Third, Malaysia's exports to China accounted for the largest share of Singapore's GDP embodied in bilateral exports between foreign countries in 2017, with China's exports to the US accounting for the second largest share.

Over the years, sustained efforts to bolster our linkages with other economies, such as through bilateral and multilateral trading agreements, have increased the economic value of our trading links with many economies around the world, including the ASEAN economies and China. This is manifested in the VA that we derive from our gross exports of goods and services to these economies, as well as the VA embodied in the exports originating from these economies. Going forward, Singapore will continue to diversify and build up our linkages with various economies around the world, especially those with high-growth potential. This will help to position the Singapore economy for growth over the longer term.

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ANNEX: METHODOLOGY

We used an input-output (IO) multiplier framework to calculate the VA generated by Singapore's gross exports, as well as Singapore's VA embodied in foreign exports by other economies.[7] To illustrate, we will use Singapore's gross exports to the US and China's gross exports to the US as examples.

The matrix equation for computing Singapore's VA generated by Singapore's gross exports to the US can be written as:

$$VA_{SG,SG,US} = \widehat{V_{SG}}\, B_{SG,SG}\, \widehat{X_{SG,US}}$$

where $\widehat{V_{SG}}$ is the 34 x 34 diagonal matrix of VA coefficients for Singapore

$B_{SG,SG}$ is the Singapore submatrix of the world's matrix of total requirement coefficients (also known as the Leontief inverse)[8], specifically the 34 x 34 matrix where the rows and columns correspond to Singapore's industries

$\widehat{X_{SG,US}}$ is the diagonal matrix derived by diagonalising the 34 x 1 vector of gross exports from each of Singapore's industries to the US

$VA_{SG,SG,US}$ is the 34 x 34 matrix where the each element in row i and column j shows the amount of VA generated by Singapore industry i from Singapore industry j's gross exports to the US

Similarly, the matrix equation for computing Singapore's VA embodied in China's gross exports to the US can be written as:

$$VA_{SG,CN,US} = \widehat{V_{SG}}\, B_{SG,CN}\, \widehat{X_{CN,US}}$$

where $\widehat{V_{SG}}$ is the 34 x 34 diagonal matrix of VA coefficients for Singapore

$B_{SG,CN}$ is a submatrix of the world's matrix of total requirement coefficients (also known as the Leontief inverse), specifically the 34 x 34 matrix where the rows correspond to Singapore's industries, and the columns correspond to China's industries

$\widehat{X_{CN,US}}$ is the diagonal matrix derived by diagonalising the 34 x 1 vector of gross exports from each of China's industries to the US

$VA_{SG,CN,US}$ is the 34 x 34 matrix where the each element in row i and column j shows the amount of VA from Singapore industry i embodied in China industry j's gross exports to the US

The matrix equation for computing Singapore's total VA embodied in China's exports to the US can be written as:

$$SGVA = v^{T} VA_{SG,CN,US} v$$

where v is a 34 x 1 vector of 1's.

7 *For more details on computing value added from gross export flows, please refer to OECD (2017).*
8 *The world's Leontief inverse matrix is the 34N x 34N matrix, where N is the total number of economies (N=64 in the OECD ICIO).*